

How Biology Perceives Chemistry: The Mammalian Olfactory System

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The classification of the vast number and diversity of odorant molecules has been a controversial topic in psychophysics and more recently in molecular physiology and systems biology of the olfactory system. In color perception there is a generally agreed upon set of rules determining how a limited range of wavelengths combine to produce millions of hues. In the auditory system the combination of particular frequencies and amplitudes produces a predictable perception of tonality. No such agreement or scheme is available in olfaction and it remains virtually impossible to predict, from looking at a chemical structure, whether a molecule will have an odor or not, let alone what that quality may be. These considerations, added to the numerical challenge represented by an enormous number of odor compounds and a very large receptor family, complicate the determination of an odor map or odor code.

One reason for this lack of clarity may be that we have adopted a physical and organic chemistry scheme of molecular description and classification. This is sensible for chemists but may have little relevance for the biological sensory system – either at the molecular receptor level or at higher perceptual levels. Chemists classify molecules according to characteristics that are useful in synthesis or isolation, features that may of no importance to a biological receptor.

Accordingly we have adopted a medicinal chemistry approach in which biological function is emphasized over chemical form to reconsider such fundamental ideas as broad vs. narrow tuning, antagonism, receptor redundancy and the particular features of a molecule that interest receptors. This strategy often forces us to reorganize our classification of odors from that of a standard organic chemistry approach.